Food and feeding habits of the black pomfret, *Parastromateus niger* (Carangidae) in the Kuwaiti waters of the Arabian Gulf

by

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ABSTRACT. - Examination of 1108 stomach contents of black pomfret, *Parastromateus niger* (Bloch, 1795) from October 2003 to September 2004 revealed eight major food groups by a decreasing order of abundance: Bacillariophyceae (23%), fish eggs and larvae (21%), crustaceans (20%), poriferans (15%), annelids (10%), cnidarians (5%), fish scales (4%) and chaetognaths (2%). Copepods were the commonest prey types, with an annual frequency of occurrence of 77%, followed, among the crustaceans, by brachyuran zoea (65%), postlarvae of shrimp (29%) and penaeid shrimps (16%). These were followed by the cnidarians, with hydroid medusae (67%), the annelids, with polychaete larvae (63%), then sponge spicules (poriferans) (54%) and fish scales (45%). *Coscinodiscus* spp. and *Rhizosolenia* spp. were the commonest prey types among the phytoplankton diet with frequencies of occurrence of 50% and 40%, respectively. While copepods, brachyuran zoea, chaetognaths, polychaete larvae, sponge spicules and hydroid medusae were ingested throughout the year, the remaining prey types exhibited some seasonal fluctuations. A low feeding intensity was recorded as the temperature increased from March to August, a period coinciding with the highest number of fish with empty stomachs. Conversely, a greater feeding activity was recorded as the temperature decreased from September to February, a period coinciding with the highest number of fish with 1/2, 3/4 and full stomachs. The proportion of fish eggs and larvae in stomach contents increased significantly with increasing size of *P. niger*, while the proportion of crustaceans significantly decreased with increasing fish size. Although the proportions of poriferans and annelids also decreased with increasing size of *P. niger*, these decreases were not significant.

RÉSUMÉ. - Régime alimentaire de *Parastromateus niger* (Carangidae) dans les eaux du Koweit, golfe Arabique.

L'étude de 1108 contenus stomacaux de *Parastromateus niger* (Bloch, 1795) entre octobre 2003 et septembre 2004 a révélé huit principales sources de nourriture par ordre décroissant d'abondance : les Bacillariophyceae (23%), les œufs et larves de poissons (21%), les crustacés (20%), les porifères (15%), les annélides (10%), les cnidaires (5%), les écailles de poissons (4%) et les chaetognathes (2%). Les copépodes ont été les proies les plus communes, avec une fréquence d'occurrence de 77%, suivis, parmi les crustacés, des larves zoés de brachyures (65%), des postlarves de crevettes (29%) et des crevettes pénéides (16%). Ces groupes ont été suivis par les cnidaires, avec les méduses (67%), les annélides, avec les larves de polychètes (63%), puis les éponges (porifères) (54%) et les écailles de poissons (45%). *Coscinodiscus* spp. et *Rhizosolenia* spp. ont été les proies les plus communes parmi le phytoplancton avec des occurrences de 50% et 40%, respectivement. Les copépodes, les larves zoés de brachyoures, les chaetognathes, les larves de polychètes, les spicules d'éponges et les méduses ont été ingérés pendant toute l'année, les autres proies ayant présenté des variations saisonnières d'occurrence. De plus, une faible activité alimentaire a été observée alors que la température a augmenté de mars à août, période où l'on observe le nombre maximum d'estomacs vides. Au contraire, une activité alimentaire plus importante a été observée lorsque la température a diminué de septembre à février, période au cours de laquelle a été relevé le nombre maximum de poissons dont les estomacs ont été à moitié, aux trois-quarts ou complètement pleins. La proportion des œufs et larves de poissons a augmenté dans les contenus stomacaux avec la taille de *P. niger*, alors que la proportion de crustacés a diminué avec la taille de ce prédateur. La diminution de la proportion des porifères et des annélides simultanément à l'augmentation de taille de *P. niger* n'a pas été significative.

Key words. - Carangidae - *Parastromateus niger* - ISW - Arabian Gulf - Diet - Feeding habits.

The family Carangidae is a part of the pelagic community of fishes of the neritic zone of the ocean. The biology of the members of the family has been seldom studied, despite their worldwide distribution. Reports on food and feeding habits have been limited to the most important commercial species, such as *Trachurus* spp. (Cabral and Murta, 2002; Šantić *et al*., 2005) and *Seriola* spp. (Matallanas *et al.*, 1995; Pipitone and Andaloro, 1995; Barreiros *et al.*, 2003).

Fish food and feeding habits studies are helpful in identifying some of the higher-level trophic relations in an ecosystem. From a practical standpoint, information on the quantity and quality of food consumed by fish is needed for estimating fish production (Paloheimo and Dickie, 1970; Mills and Fournier, 1979). In addition, knowledge of the feeding ecology of commercial as well as non-commercial fish species is essential for implementing a multispecies approach to fisheries management (Gulland, 1977; Larkin, 1978).

In the Kuwaiti waters of the Arabian Gulf, the carangid species, *Parastromateus niger* (Bloch, 1795), contributes to

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the multispecies commercial fishery. These fishes inhabit depths of 15-40 m, in muddy substrata, near the bottom during daytime and near the surface at night, and are caught by gill-nets and trawls (Carpenter *et al.*, 1997). Information on *P. niger* landings in Kuwait is sketchy; however, unpublished FAO data for 1997 quoted by Bishop (2002) indicate total landings of 325 tonnes for all the carangids.

Among the Arabian Gulf carangids, only the diet of the shrimp scad, *Caranx djedaba* has been reported (Euzen, 1987). Sivaprakasam (1967) studied the diet of *P. niger* from Indian waters. These are the only reports available either locally or regionally, on the commercially important *P. niger*. The present study was, therefore, carried out to gain knowledge of the trophic niche of this species within the ecosystem. The objectives of this study were to describe: (1) diet, (2) frequency of occurrence of different food items in the stomach, (3) seasonal changes in diet composition, (4) feeding intensity, and (5) food in relation to fish size.

MATERIALS AND METHODS

Study site

Fresh samples of *P. niger* were collected from commercial gill-net catches in the northern part of the Kuwaiti waters of the Arabian Gulf (Fig. 1), during a 12-month sampling period from October 2003 to September 2004. The nets used were 1000-2500 m in length, with a mesh stretched size of 13.8 cm. They were set 2-5 km offshore at depths ranging from 7 to 15 m. They were set at dawn between 03:00 and 05:00; then raised and the fish collected between 13:00 and 14:00. The vessels with *P. niger* catches docked by 15:30; study samples were collected between 15:30 and 17:00 hours and kept on ice.

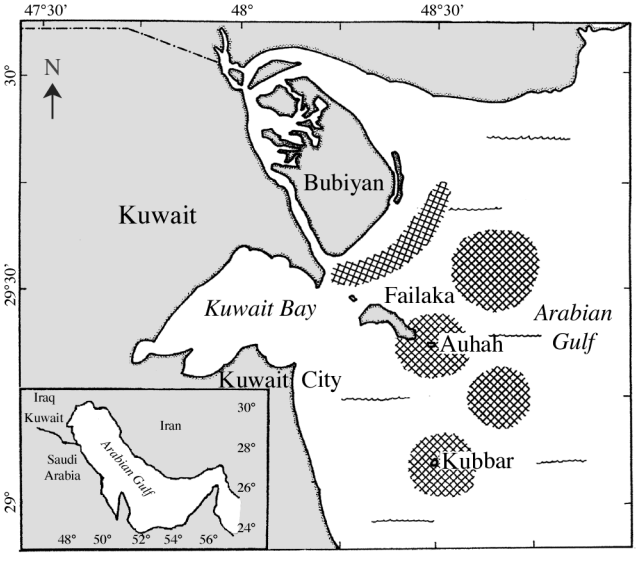

Figure 1. - Map of the Kuwaiti waters of the Arabian Gulf, showing the fishing areas (hatched). *[Carte des eaux koweitiennes dans le golfe Arabique, et localisation des zones de captures (hachures).]*

Data analysis

After dissection in the laboratory, the degree of stomach fullness was assessed according to the subjective scale described by Lebedev (1946) as empty, 1/4 full, 1/2 full, 3/4 full or full. The data were then used to calculate a monthly fullness index (FI):

$$FI = \frac{\text{Number of stomachs with the same degree of fullness}}{\text{Total number of stomachs examined}} \times 100$$

The gut was then excised, weighed (g) together with its contents, and preserved in 70% alcohol. Subsequently, stomach contents were weighed separately, suspended in water in Petri dishes, and all prey items identified to the lowest possible taxon using two identification references for the plankton of Kuwait waters (Al-Yamani and Prusova, 2003; Al-Yamani *et al.*, 2004). For each stomach, the items of each prey category were counted, except for algae, which were counted as one item per colony. Unidentifiable prey fragments, described as miscellaneous items, were also considered as one item. Mean monthly temperature values of the Kuwaiti waters during the period of the study, obtained from the Kuwait Environmental Protection Authority, were used to establish the effects of temperature on feeding intensity.

The contribution of each food type to the diet and the frequency of occurrence were determined according to Hynes (1950) as the number of stomachs in which a prey item occurred, expressed as a percentage of the total number of stomachs examined.

The proportion of the prey items identified in each group for the entire year was determined according to the number method (Bowen, 1985) as the number of food items of each food type for each fish examined expressed as a percentage of the total number of food items counted. Monthly variation of prey abundance in the stomach contents was investigated to determine the seasonal changes in the diet of the species, using the frequency of occurrence method. Finally, the variation in diet with length of *P. niger* was investigated by regrouping the fish into 12 size classes at 3.0 cm standard length (SL) intervals and assessing the gut contents based on the major food groups with an occurrence of 10% or more in the stomachs, using the percentage occurrence data.

The results of the study were subjected to the following statistical analyses: t-test, for establishing the relationship between water temperature and feeding intensity; post-hoc test, for testing the seasonal variations in diet composition; χ^2, for testing the variation of empty stomachs over the year

Table I. - Monthly frequency of occurrence of different prey types in *Parastromateus niger* stomachs from October 2003 to September 2004. *[Fréquences d'occurrences mensuelles des différentes proies de* P. niger *présentes dans les estomacs d'octobre 2003 à septembre 2004.]*

Prey type	Frequency of occurrence (%)											
	O	N	D	J	F	M	A	M	J	J	A	S
Crustacea												
Copepoda	21.2	81.4	80	71.5	80.7	85	80.6	81.4	78.3	83.3	91.9	93.6
Cladocerans	19.2	14	0	0	0	0	0	0	0	0	0	0
Ostracods	19.2	16.3	0	0	0	4	0	0	0	0	0	0
Barnacle nauplii	13.5	25.6	0	0	0	0	0	0	0	0	0	0
Cypris of barnacle	11.5	0	0	0	0	0	0	0	0	0	0	0
Zoeae of pagurids	9.6	20.9	0	0	0	0	0	0	0	0	0	0
Zoeae of anomurans	11.5	6.9	0	0.8	0	0	0	0	0	0	0	0
Zoeae of brachyurans	13.5	23.3	60	69.9	67.3	76	78.7	64.7	70.6	86.3	75.8	93
Megalopa of brachyurans	15.4	14	1.4	2.4	1.9	6	0.9	2.9	7.8	39.2	0	0
Zoeae of shrimp	9.5	9.3	0	0	0	0	0	2	0	0	0	0
Protozoeae of shrimp	13.5	18.6	0	0	0	0	0	0	0	0	0	0
Mysis of shrimp	9.6	14	0	0	0	0	0	0	0	0	0	0
Postlarvae of shrimp	0	0	0	7.3	10.6	27	33.3	40.9	48	44.1	63.6	73.4
Caridean of shrimp	9.6	6.9	0	0	0	0	0	0	0	0	0	0
Penaeid of shrimp	0	0	0	0	2.9	14	22.2	18.6	34.3	37.3	34.3	23.4
Caprilled of amphipods	11.5	6.9	0	0	0	0	0	0	0	0	0	0
Cumacean spp.	0	11.6	0	0	0	0	0	0	0	0	0	0
Isopods	11.5	20.9	0	0	0	1	0	0	0	0	0	0
Other crustacean nauplii	5.8	4.6	1.4	0	0	0	0	0	0	0	0	0
Crustacean exoskeleton	17.3	34.9	0	3.3	1.9	0	4.6	2	2	1	0	3.2
Mollusca												
Bivalve larvae	11.5	20.9	0	0	0	0	0	0	0	0	0	0
Gastropod larvae	21.2	14	0	0	0	0	0	0	0	0	0	0
Loligo spp.	0	0	0	1	0	10	6.5	3.9	0	0	0	0
Octopus	0	0	0	0	0	1	0	0	0	0	0	0
Snails	0	0	0	0.8	1	0	0	0	0	0	0	0
Echinodermata												
Larvae	13.5	23.3	0	0.8	0	0	0	0	0	0	0	0
Juvenile	15.4	11.6	1.4	0	0	0	0	0	0	0	0	0
Chaetognatha												
Chaetognaths	13.5	34.9	50	25.2	52.9	57	68.5	65.7	53.9	54.9	55.6	60.6
Annelida												
Polychaetes	15.4	34.9	2.9	1.6	1	0	0	0	0	0	0	0
Polychaete larvae	19.2	14	62.9	71.5	85.5	62	72.2	69.6	71.6	74.5	71.7	82.9
Other annelids	13.5	20.9	62.9	21.1	44.2	32	17.6	10.8	9.8	11.8	11.1	17
Protozoa												
Tintinnids	7.7	18.6	0	0	0	0	0	0	0	0	0	0
Foraminiferans	11.5	6.9	0	0	0	0	0	0	0	0	0	0
Other protozoans	21.2	16.3	0	0	1	0	0	0	0	0	0	0
Porifera												
Sponge spicules	15.4	30.2	71.4	65	51	52	54.6	61.8	51	65.7	64.6	70.2
Cnidaria												
Hydroid medusae	5.8	37.2	67.1	82.1	84.6	83	75.9	77.4	72.5	76.5	71.7	73.4
Hydroid polyps	15.4	11.6	1.4	0	0	0	0	0	0	0	0	0

Table I. - Continued. *[Suite.]*

Prey type	Frequency of occurrence (%)											
	O	N	D	J	F	M	A	M	J	J	A	S
Chordata												
Fish eggs	30.8	34.9	41.4	0	24	71	34.3	41.2	0	4.9	35.4	14.9
Fish larvae	13.5	34.9	0	0	0	0	0	0	0	1	5.1	1.1
Fish scales	0	14	25.7	47.2	42.3	50	56.5	52.9	55.9	59.8	68.7	68.1
Juvenile fish	0	0	0	0	0	4	0	0	0	0	0	0
Bacillariophyceae												
Coscinodiscus spp.	3.8	18.6	1.4	0	38.5	53	77.8	76.5	78.4	79.4	79.8	89.4
Rhizosolenia spp.	19.2	16.3	25.7	0	62.5	26	59.3	53.9	50	56.9	62.6	52.1
Hemidiscus spp.	9.6	14	0	0	0	0	0	0	0	0	0	0
Other diatoms	3.8	4.6	4.3	2.4	0	0	0	0	0	0	0	0
Dinophyceae												
Ceratium spp.	15.4	23.3	0	0	0	0	0	0	0	0	0	0
Other dinoflagellates	17.3	11.6	0	0	0	0	0	0	0	0	0	0
Chlorophyceae												
Enteromorpha spp.	11.5	16.3	0	0	0	0	0	0	0	0	0	0
Other filamentous algae	21.2	23.3	0	0	0	0	0	0	0	0	0	0
Sand grains	15.4	9.3	8.6	4.1	0	1	0	0	0	0	0	0
Miscellaneous matter	26.9	41.8	100	100	99	100	100	100	98	100	100	100
Number of fish examined	52	48	70	124	102	100	107	102	102	102	99	99

and correlation coefficient tests, for testing the significance of the relationships between food and fish size. All calculations were carried out using Minitab 14 statistical software (Minitab, 2003).

RESULTS

The standard length (SL) of the 1108 fish examined ranged from 13.5 to 50.0 cm, and the total weight from 86.3 to 2991.5 g. In the great majority of stomachs examined, the contents were at an advanced stage of digestion, which made identification of food items to the species level very difficult.

Food items

In the 1108 stomachs examined, 50 taxa, excluding miscellaneous items and sand grains, were identified from the stomach contents of *Parastromateus niger* (Tab. I). The prey types identified during the entire year showed the dominance of three major dietary components: Bacillariophyceae, which accounted for 23% of the diet; fish eggs and larvae, contributing 21% of the diet and crustaceans, accounting for 20% of the diet (Fig. 2). The other major components were Porifera (15%), Annelida (10%), Cnidaria (5%), fish scales (4%) and Chaetognatha (2%).

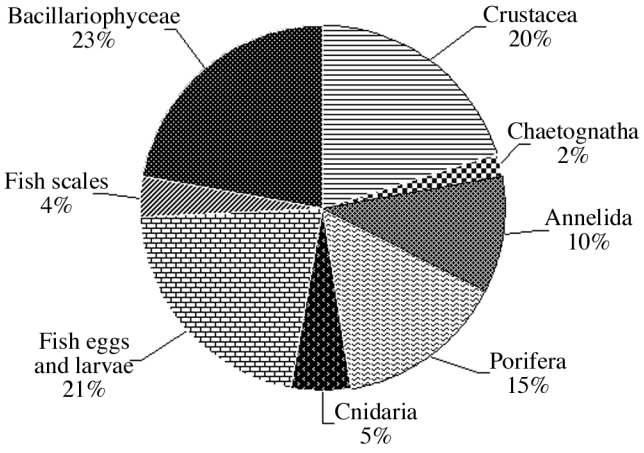

Figure 2. - Proportion of major prey groups in the stomachs of *Parastromateus niger* from October 2003 to September 2004. *[Proportions des principaux groupes de proies dans les estomacs de* P. niger *d'octobre 2003 à septembre 2004.]*

Frequency of occurrence of different food items

Crustaceans were the most common food items in the stomachs of *P. niger* during the year, with copepods occurring at the highest frequency (77%), followed by brachyuran zoeae (65%), postlarvae of shrimp (29%) and penaeids of shrimp (16%) (Fig. 3). Other crustaceans occurred at lower frequencies (< 10%). The next most common food items

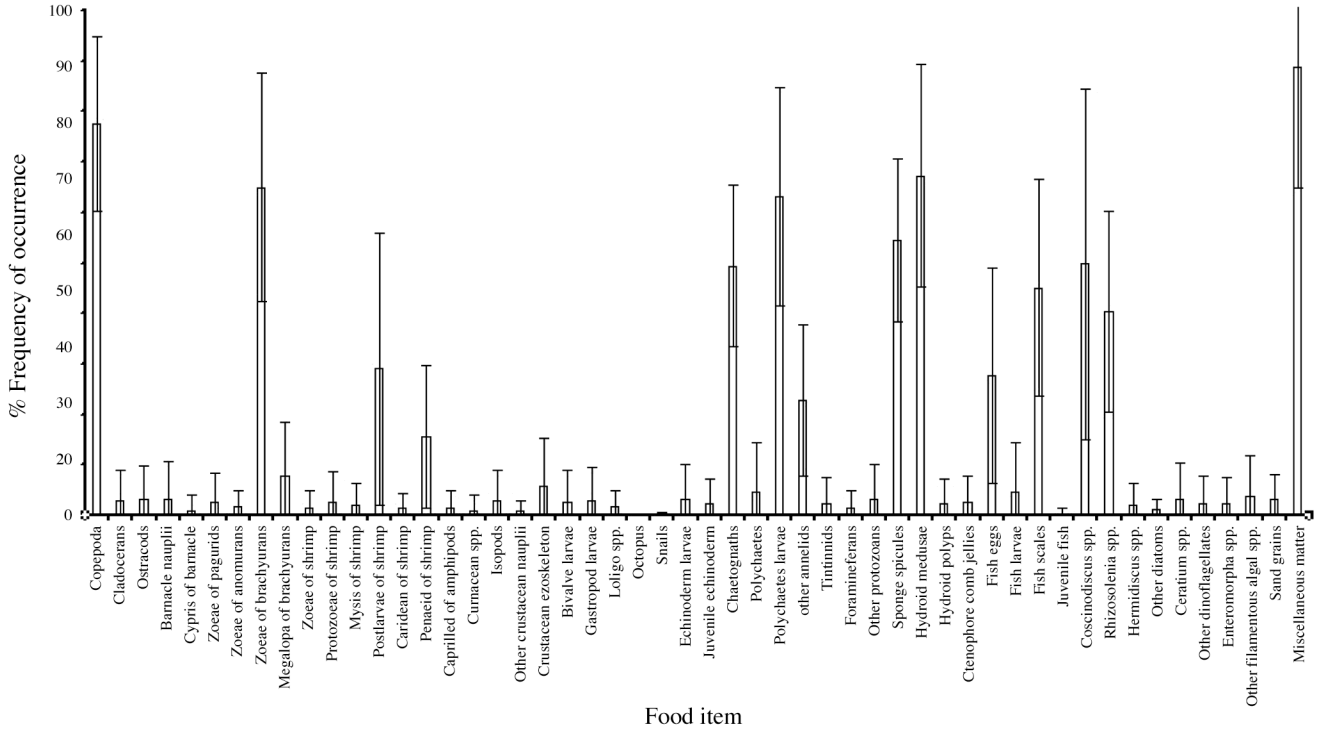

Figure 3. - Frequency of occurrence of different food items in the diet of *Parastromateus niger* from October 2003 to September 2004. Vertical bars indicate standard deviations. *[Fréquences d'occurrences des différentes catégories de proies dans l'alimentation de* P. niger *d'octobre 2003 à septembre 2004. Les barres verticales indiquent l'écart-type.]*

were the cnidarians, of which hydroid medusae occurred at a frequency of 67%. Cnidarians were followed by annelids, with polychaete larvae occurring in 63% of the stomachs. Sponge spicules (Porifera) occurred in 54% of the stomachs, while fish scales occurred in 45% of the stomachs. Among the phytoplankton, *Coscinodiscus* spp. and *Rhizosolenia* spp. occurred in 50 and 40% of the stomachs, respectively.

Seasonal changes in diet composition

Copepods and brachyuran zoeae occurred most frequently in the stomachs during the study period (Tab. I). Megalopae were eaten all months, except August and September 2004, while postlarval shrimp were eaten all months, except from October to December 2003. Penaeid shrimp were absent from October 2003 to January 2004. The remaining crustaceans were eaten only in October and November 2003.

In all months, Chaetognatha species were frequently found in the diet, with relatively higher occurrences from February to September. Polychaete larvae and other annelid species also occurred consistently every month, with polychaete larvae registering some of the highest frequencies encountered. The consumption of Protozoa was restricted to October-November, while sponge spicules (Porifera) were present in the stomachs throughout the year with peaks in December 2003 and September 2004. Of the cnidarians, hydroid medusae occurred in the stomachs at very high frequencies every month from December 2003 to the end of the study in September 2004, while hydroid polyps occurred only from October to January. Fish eggs were eaten every month except in January and June. In all months, fish scales regularly occurred in the stomachs with increasing frequency from March to September.

Diatoms (*Coscinodiscus* spp. and *Rhizosolenia* spp.) were both present throughout the year except in January. *Hemidiscus* sp. were present only in October-November, while other unidentifiable diatoms occurred from October 2003 to January 2004. Species of the dinoflagellate, *Ceratium* spp., and other unidentifiable ones, as well as species of the chlorophyta, *Enteromorpha* spp., and other unidentifiable filamentous algae were all eaten only in October-November. The post-hoc test revealed that all the seasonal variations in diet composition were significantly different ($p < 0.05$).

Feeding intensity

The fullness index of the stomach underwent monthly variations (Fig. 4). One-quarter full stomachs dominated the samples during most months, followed by 1/2 full stomachs, then 3/4 full- and full stomachs. Full stomachs dominated the samples only in September. Of the 1108 stomachs examined, 261 (23.5%) were empty. The proportion of empty stomachs varied significantly over the year ($\chi^2 = 101.5$,

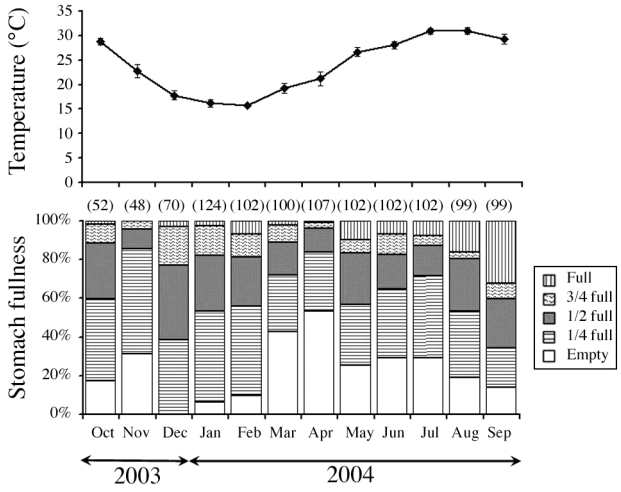

Figure 4. - Monthly temperature values from Kuwaiti waters (top) and monthly variations in stomach fullness (bottom) of *Parastromateus niger*. Vertical bars in figure on top indicate standard deviations, and figures in parentheses in figure at the bottom indicate number of fish. *[Températures mensuelles des eaux koweitiennes (haut) et variations mensuelles du remplissage des estomacs de* P. niger *(bas). Les barres verticales en haut indiquent l'écart-type, et les valeurs entre parenthèses en bas indiquent le nombre d'individus.]*

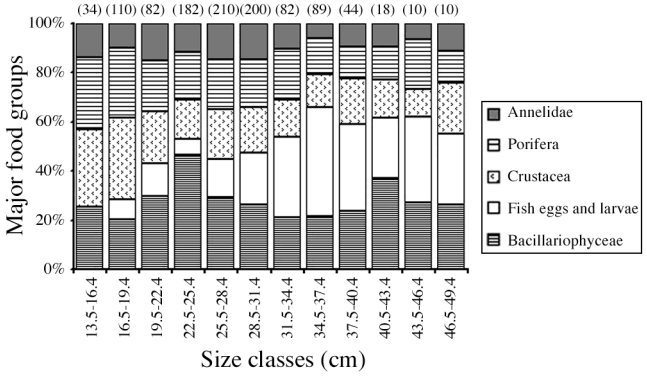

Figure 5. - Composition of *Parastromateus niger* diet among size classes, based on percentage occurrence of the major food groups. Figures in parentheses indicate number of fish. *[Composition de l'alimentation de* P. niger *en fonction de la classe de taille, fondée sur le pourcentage d'occurrence des principaux groupes de proies.]*

$p < 0.05$). The maximum proportion of empty stomachs occurred in March (43%) and April (57%), while the minimum were recorded in January (8%) and February (10%). Overall, more empty stomachs were found from March to August 2004 (av. 33.2%) than from October to February and September (av. 13.2%). Low feeding intensity was recorded as the temperature increased from March to August, a period when empty stomachs significantly dominated over 1/2, 3/4 and full stomachs ($p < 0.05$). On the other hand, high feeding intensity was recorded as the temperature decreased from September to February, as 1/2, 3/4 and full stomachs significantly dominated over empty stomachs ($p < 0.05$).

Food in relation to fish size

All the major food groups occurred in the diet of all fish size classes, except fish eggs and larvae, which were absent from the smallest size class (Fig. 5). However, with the appearance of fish eggs and larvae in the stomachs of fish in the next size class (16.5-19.4 cm SL), the frequency of these food items increased significantly with increasing fish size ($r = 0.815$, $p < 0.05$). On the other hand, the proportion of crustaceans significantly decreased with increasing size of *P. niger* ($r = -0.698$, $p < 0.05$). The proportions of poriferans and annelids also decreased with increasing fish size, but the decrease was not significant ($r = -0.388$, $p > 0.05$ for poriferans, and $r = -0.319$, $p > 0.05$ for annelids). Bacillariophyceae were the most important prey group in seven of the 12 size classes, i.e., in the four SL size classes between 19.5 and 31.4 cm and the three SL size classes from 40.5 to 43.4 cm.

DISCUSSION

From the results of this study, it is evident that almost every animal phylum and some phytoplankton contribute to the diet of *Parastromateus niger*. Although Bacillariophyceae, fish eggs and larvae and crustaceans constituted the major components of the diet, the most common invertebrate prey items were copepods, hydroid medusae, brachyuran zoeae, polychaete larvae, and sponge spicules plus fish scales.

These results are different from the only existing report on the species carried out in the region. Sivaprakasam (1967) reported that Thaliacea were the most abundant food items of *P. niger* in the Saurashtra coast in India, followed by crustaceans. Among the crustaceans, prawns, shrimps and amphipods formed the major items, while copepods, the most important prey item in the present study, occurred only occasionally in the stomach contents of this species in Indian waters. While the phytoplankton species, *Coscinodiscus* spp. and *Rhizosolenia* spp., were major items in the diet of *P. niger* in Kuwait, Sivaprakasam (1967) observed no phytoplankton in the diet of the Indian representatives of the species. In the other carangid studied from Kuwait (*Caranx djedaba*), fish and zooplankton dominated in the stomachs (Euzen, 1987). The results from the present study thus suggest that in Kuwaiti waters, the black pomfret feeds on a wide variety of food items, including both zooplankton and phytoplankton.

P. niger was previously placed in the family Stromateidae and considered as a close relative to its sympatric pom-

fret relatives, the silver pomfret, *Pampus argenteus* and the Chinese pomfret, *Pampus chinesis* (Sivaprakasam, 1967). Therefore, in the absence of any reports on the feeding ecology of *P. niger* or other carangids locally, the results of this study are compared with those of Dadzie *et al.* (2000) on *P. argenteus*. Crustaceans, bacillariophyta, fish scales and fish eggs were among the major prey groups of *P. argenteus* in Kuwaiti waters (Dadzie *et al.*, 2000). Furthermore, copepods were the most important prey items among the crustaceans, while *Coscinodiscus* spp. and *Rhizosolenia* spp. constituted the main phytoplankton items in the diet. Information available from Indian waters on *P. argenteus* indicated that the species feeds principally on crustaceans, with copepods constituting the dominant prey type (Kuthalingam, 1967; Rao, 1967; Pati, 1980), with phytoplankton, including *Coscinodiscus* spp. and *Rhizosolenia* spp., also being important (Kuthalingam, 1967; Pati, 1980). From this study, it may be concluded that *P. niger* exploits common food resources in Kuwaiti waters and also feeds, more or less, on common food items, similar to its sympatric pomfret species, *P. argenteus*.

Copepods are the most important food items in the diet of *P. niger* in Kuwait throughout the year, as was observed in *P. argenteus*. However, relatively minor seasonal fluctuations were observed in the diet in *P. niger*. The occurrence of the remaining most common items followed a similar pattern, with little seasonal fluctuations. In contrast, the occurrence of fish scales exhibited a clear pattern of seasonal fluctuation as well as the occurrence of *Coscinodiscus* spp. and *Rhizosolenia* spp., similar to the observations made in *P. argenteus*.

Seasonal fluctuations in diet composition of fishes elsewhere have been attributed to the influence of the monsoons, when peak occurrences of certain food organisms are observed (Pati, 1980) and seasonal fluctuations in water temperature when food organisms peak in summer and reach a minimum in winter (Dadzie *et al.*, 2000; Šantić *et al.*, 2005). In the present study, *Coscinodiscus* spp. and *Rhizosolenia* spp. in the gut analysis exhibited the lowest occurrence from October to February/March, a period coinciding with the winter months in Kuwait, while the increase in the occurrence of these food items from April to September coincided with the spring/summer months. Consequently, the seasonal fluctuations in the main phytoplankton diet of *P. niger* observed in Kuwaiti waters may be attributed to seasonal changes

The pattern of feeding intensity investigated through the analysis of fluctuations in the stomach fullness indices revealed monthly variations. Stergiou (1988), Kurup (1993) and Dadzie *et al.* (2000) reported that low feeding intensity in fish is synchronized with their spawning seasons. Similar observations were made in the present study. From our ongoing research (Dadzie, unpublished data), spawning of *P. niger* in Kuwaiti waters takes place from March to September. Available reports (Sobhana and Nair, 1980; Geetha *et al.*, 1990) suggest that the high occurrence of empty stomachs during the spawning season of fishes is due to the decreased feeding activity since the mature gonads take up more space in the peritoneal cavity, compressing the stomach and making feeding more difficult. These reports are in agreement with the observations on *Pampus argenteus* in Kuwait (Dadzie *et al.*, 2000) as well as those inhabiting Indian waters (Kuthalingam, 1967; Pati, 1980) that feeding is intensive during the early stages of maturity and decreases as the gonads mature. Similar conclusions are drawn in the present study. Kuthalingam (1967) further observed that in mature fish, the space inside the body cavity was reduced because of the growth of the reproductive structure pushing the digestive organ toward the dorsal side.

Feeding intensity through the analysis of stomach fullness has also been correlated with seasons, being negatively related to the percentage of empty stomachs (Bowman and Bowman, 1980; Cabral and Murta, 2002; Šantić *et al.*, 2005). Feeding intensity decreases during the winter months, due either to a temperature-dependent physiological process (Šantić *et al.*, 2005), a strong temperature-dependent regulation on food intake (Temming and Hermann, 2001), or lesser abundance of prey and the lowered metabolism of the fish, which probably reduce predation during the winter (Šantić *et al.*, 2005). In contrast, the present study revealed the monthly variations in stomach fullness to include a rather low feeding intensity during periods of high temperature and a high feeding intensity during the period of low temperature. These findings strengthen the evidence that in Kuwaiti waters, feeding intensity in *P. niger* is related to the reproductive cycle rather than the seasonal climatic changes.

In terms of ontogenetic changes in food habits, it is realized that all the major food groups in the diet occur in the diet of all fish size classes. However, the increased frequency of occurrence of fish eggs and larvae with increasing size of *P. niger* and the decrease in the proportion of crustaceans, poriferans and annelids with increasing fish size, lead to the conclusion that although food habits of the species do not change with fish size, the frequencies of occurrence of the major food groups generally do change with size, similar to the case of *Pampus argenteus* (Dadzie *et al.*, 2000) in Kuwaiti waters.

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